NON-PUBLIC?: N
ACCESSION #: 9405130195
LICENSEE EVENT REPORT (LER)

FACILITY NAME: Calvert Cliffs, Unit 1 PAGE: 1 OF 7

DOCKET NUMBER: 05000317

TITLE: Unit 1 Reactor Trip and ESFAS Actuation Due to 12 120 VAC Inverter
EVENT DATE: 01/24/94 LER #: 94-001-00 REPORT DATE: 02/18/94

OTHER FACILITIES INVOLVED: DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR SECTION:
50.73(a)(2)(viii)(A) and 73.71(b)

LICENSEE CONTACT FOR THIS LER:
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COMPONENT FAILURE DESCRIPTION:
CAUSE: X SYSTEM: ED COMPONENT: ECBD MANUFACTURER: E355
X ED ECBD E355
X ED FU E355
REPORTABLE NPRDS: Y
Y
Y

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On January 24, 1994, at 0926, Calvert Cliffs Unit 1 experienced a reactor trip and partial actuation of system ZB of the Engineered Safety Features Actuation System (ESFAS). The reactor trip and ESFAS actuation occurred due to fluctuations in the output voltage from 12 120 VAC Vital Bus Inverter. The inverter output voltage fluctuated due to a defective voltage regulator board within the inverter. At the time of the event, Unit 1 was at 100 percent power with normal operating temperature and pressure.

Troubleshooting after the event identified the defective regulator board. The board appeared to be defective either due to a loose fuse in the

voltage feedback circuit or due to a screw found wedged between the boards of the card. Additional inspections identified a loose capacitor and defective oscillator board.

Corrective actions include the inspection of the other inverters on Unit 1 and 2, replacement of the inverter with upgraded models, and an evaluation to determine if debris intrusion controls for the inverters are adequate.

END OF ABSTRACT

I. DESCRIPTION OF EVENT

On January 24, 1994, at 0926, Calvert Cliffs Unit 1 experienced a reactor trip and partial actuation of subsystem ZB of the Engineered Safety Features Actuation System (ESFAS). The trip and ESFAS actuation occurred due to fluctuations in the output voltage from 12 120 VAC Vital Bus Inverter. Although some components were affected by the loss of inverter voltage, plant response to the event was in accordance with design. The inverter output voltage fluctuated due to a defective voltage regulator board within the inverter. Output voltage from the inverter was completely lost when a protective fuse within the inverter blew. At the time of the event, Unit 1 was operating at 100 percent power with normal operating temperature and pressure.

At approximately 0826 on January 24, 1994, instrument maintenance technicians commenced Surveillance Test Procedure (STP) M-212E.1 on Unit 1. This STP is used to test portions of the Reactor Protective System (RPS) logic and matrix functions. The technicians completed steps involving testing of the RPS matrix and channel functions, and moved on to testing the "Matrix Relay/Channel Trip Relays." There are eight reactor trip circuit breakers (TCBs) in the RPS system, grouped in four pairs. Each pair is controlled by a TCB control relay which receives inputs from the logic matrix relays.

The trip paths controlling TCBs 1 and 5 and 2 and 6, were tested first, Both TCB pairs were opened individually during the testing and then restored to their normal closed position. At approximately 0916 the technicians proceeded to test the third trip circuit and opened TCBs 3 and 7. At 0926, the 12 120 VAC Vital Bus Inverter output voltage fluctuated, causing a loss of power to TCB control relay K2, allowing TCBs 2 and 6 to open. With TCB pairs 3 and 7 and 2 and 6 open, the Control Element Assembly (CEA) hold coils were deenergized allowing all of the CEAs to drop into the reactor core. Additionally, undervoltage

conditions downstream of the TCBs were sensed satisfying the logic for a reactor trip bus undervoltage relay in the ESFAS ZB cabinet. Actuation of this relay provided a trip signal to the Main Turbine. The Main Turbine then tripped and provided a signal to the RPS to open the remaining four TCBs.

The output from 12 Inverter supplies 120 VAC input to the 1Y02 Vital 120 VAC Bus. This bus in turns supplies power to the Channel ZB ESFAS actuation logic cabinet 15 and 28 VDC power supplies. The 15 VDC supply is used to provide power to the logic module coincident circuitry, whereas the 28 VDC supply provides power to the final output circuitry of the modules. It appears that when the output voltage from the inverter started to fluctuate, the 15 VDC power supply in the Channel ZB ESFAS actuation cabinet decayed to a voltage value

below the voltage trip threshold. Although the voltage decayed sufficiently to adversely affect the coincident circuitry, the 28 volt power supply voltage was still high enough to cause the output circuitry to function properly and provide actuation signals to ESFAS Channel ZB components. When voltage from the inverter to the ESFAS cabinet was lost completely the coincident and output circuitries returned to their preactuation states. At no point in this event did the sensors in the ESFAS sensor cabinets actually detect adverse conditions in the plant.

One of the resulting ESFAS actuations was the undervoltage relay on safety-related 4 kv Bus 14. When this relay actuated a signal was provided to trip the normal feeder breaker and safety-related loads on Bus 14 and to initiate the start of 12 Emergency Diesel Generator (EDC). Engineered Safety Features Actuation System components like 12 Low Pressure Safety Injection Pump that received breaker close signals from ESFAS output circuitry simultaneously received breaker open signals from the undervoltage relay and thus the pump did not actually start to operate.

As noted above 12 EDC started after receiving & signal from the undervoltage relay. It did not sequence onto Bus 14 and load components because the complete loss of power to the ESFAS cabinet, after the protective fuse in the inverter blew, rendered 12 EDG's sequencers inoperable. To restore power to the Bus 14, a licensed utility reactor operator closed in the alternate feeder breaker to the bus. To restore power to 1Y02, the inverter was isolated and the backup supply to the bus was placed in service.

Because the EDC started from a cold condition, the operators decided to

manually load and run the EDG in accordance with current plant polic
es.
The operators synchronized the EDG with Bus 14 and were in the process of raising load on the EDG when the EDG output breaker tripped open at about 250 kw. They then unsuccessfully attempted to synchronize with the 21 4 kv bus. Operators were dispatched to the EDG breaker and discovered the reverse power trip relay flag was in the tripped condition, thus preventing the EDG breaker from closing. After resetting the relay flag they successfully loaded the EDC onto 21 Bus.

Other than the unique initiation of the ESFAS actuation signals discussed above, the RPS and ESFAS functioned properly. The redundant ESFAS channel to ZB, ZA, was unaffected by the loss of 12 Inverter. The loss of 12 Inverter did prevent the Main Steam Atmospheric Sump Valves (ADVs) from opening. At the time of the event the Reactor Regulating system, which controls pressurizer level, was selected to Channel Y which is powered from 1Y02. The Reactor Regulating System provides the quick open signal to both the ADVs and turbine bypass valves after

a turbine trip, so without power to the system both the ADVs and bypass valves failed to receive a quick open signal. The turbine bypass valves will also ramp open in response to rising main steam system pressure. When the ADVs and turbine bypass valves did not receive a quick open signal, pressure spiked to 998 psia in the steam generators before the turbine bypass valves reduced pressure. If pressure had bean sustained at this value the Main Steam Safety Valves would have started to open, but did not due to the opening of the turbine bypass valves.

As experienced on previous turbine trips, Main Feedwater (MEW) was lost because a close signal was provided to the MFW regulating valves for both 11 and 12 Steam Generators after the Main Turbine tripped. These valves closed faster than the Steam Generator Feedwater Pumps (SGFPs) could ramp down thus causing the pumps to trip on high discharge pressure. Auxiliary Feedwater (AFW) was manually initiated by the operators to maintain steam generator levels. A modification to correct this feedwater problem will be included in the upgrades to the feedwater system being implemented in the 1994 Unit 1 Refueling Outage.

After the trip, Technical Specification 3.8,9.1.b.2 was entered for the loss of the inverter and the Unit remained in MODE 3 while troubleshooting took place. When efforts to isolate and repair the inverter approached the allowed Technical Specification out of service time, the Unit was cooled down to MODE 5 in accordance with the Technical Specification and an Unusual Event was declared in accordance with the

Emergency Response Plan Implementation Procedures.

II. CAUSE OF EVENT

The root cause of the Unit 1 reactor trip on January 24, 1994, was the failure of 12 120 VAC Vital Inverter due to a faulty voltage regulator board. Post-trip troubleshooting identified both a loose fuse in voltage feedback circuit and a loose panel screw, from an unidentified source, stuck between the two cards that make up the voltage regulator board. Either one of these conditions could have caused voltage fluctuations within the regulator board. These fluctuations may have caused a transistor on the board to become defective which may have led to the failure of the board itself.

The investigation also determined the total loss of inverter output voltage occurred when a protective fuse in the inverter blew. Troubleshooting determined two conditions which could have caused this fuse to blow: (1) the failure of the voltage regulator board and or (2) a capacitor that controls sequencing of the Silicon Controlled Rectifiers (SCRs) in the inverter with loose connection.

After the Unit 1 trip on January 24, 1994, the voltage regulator card was replaced and static and dynamic load testing was performed on the inverter. The inverter was returned to service and declared OPERABLE on January 25, 1994 at approximately 1400. At around 1600 on January 25, 1994, the protective fuse in the inverter failed again and the inverter was removed from service. At this point troubleshooting identified the oscillator board was now defective and the card was replaced. The loose fuse in voltage feedback circuit and the loose capacitor connection were also found at this time and both were tightened. Static testing was then performed and during this testing the protective fuse blew once again (it was later determined the fuse blew during this testing due to faulty test equipment). While testing was in progress, Operations conservatively elected to treat the inverter as inoperable since the unit trip on January 24, and in accordance with Technical Specification 3.8.9.1.b.2 commenced a cooldown from MODE 3 (Hot Standby) to MODE 5 (Cold Shutdown). After performing the maintenance described above and successful testing, the inverter was declared operable and returned to service at approximately 0530 on January 30, 1994.

III. ANALYSIS OF EVENT

The ESFAS system initiates the start of equipment designed to mitigate and terminate a loss of reactor coolant, a main steam line break, or a

loss of feedwater event. The ESFAS system, including both sensor and actuation systems, and the equipment it operates are divided into two independent and redundant subsystems designed to ensure the system responds even in the event of a single failure. Although the logic modules in Channel B of the ESFAS system were in an indeterminate stage and thus caused the actuation of ESFAS components, Channel A was unaffected by the loss of 12 Inverter. At no time during the event did the ESFAS sensors actually sense plant parameters that would satisfy the ESFAS logic modules nor did any of the ESFAS component actuations result in water being injected into the Reactor Coolant System.

The undervoltage condition and loss of Bus 14 were not considered a loss of offsite power. The normal feeder breaker to the bus opened in response to an undervoltage signal generated from ESFAS Channel B, which was effected by the fluctuating voltage supplied by 12 Inverter. Neither an actual loss of offsite power nor a fault on Bus 14 were present at the start of the event.

There were no safety consequences associated with this event and the ESFAS actuations are not considered safety significant.

This event is being reported in accordance with 10 CFR 50.73(a)(2)(iv) due to the RPS and ESFAS actuations. Additionally, it is reportable under 10 CFR 50.73(a)(2)(i)(A) because an Unusual Event was declared and the Unit was cooled down from MODE 3 to MODE 5.

IV. CORRECTIVE ACTIONS

Short Term

A. Corrective maintenance associated with 12 Inverter included the replacement of the voltage regulator board and the oscillator boards, and securing of the voltage feedback fuse and the loose capacitor.

B. All of the remaining 120 VAC inverters on both Unit 1 and Unit 2 were inspected for the problems identified an 12 Inverter. There were no problems identified with these inverters.

C. Following the event, a visual inspection of the overhead above the inverters was made to identify any loose parts or debris that could fall into the inverter cabinets. Temporary controls, were also put in place to prevent work over the inverters. The area around the inverters was roped off with

warning signs stating work above the inverters is prohibited.

D. Enhancements are being made to the Preventive Maintenance Program for the inverters. Additional checks will be performed from now on to determine if components within the inverter are degraded or defective.

Long Term

A. A Facility Change Request (FCR) will be implemented to replace the inverters with upgraded models, due to concerns about vendor support and parts availability. The Unit 1 inverters are scheduled to be replaced during the Unit 1 Refueling Outage in the Spring of 1996. The Unit 2 inverters are scheduled to be replaced during the Unit 2 Refueling Outage in the Spring of 1995.

B. The screw found between the two cards in the voltage regulator board was a panel screw that appears to have fallen from a location above

the inverter. An evaluation will be performed to determine if debris intrusion controls are adequate for the inverters.

Other

A. A Calvert Cliffs Significant Incident Finding Team (SIFT) was formed after the event to determine the event cause(s) and to recommend corrective actions. Additional corrective actions arising from this investigation will be implemented as appropriate.

V. ADDITIONAL INFORMATION

A. Failed Component Identification

IEEE 803 IEEE 805
EIIS Funct System ID

Vital Inverter Voltage
Regulator Board ECBD ED
Vital Inverter Oscillator
Board ECBD ED
Vital Inverter Output Fuse FU ED

B. Previous Similar Events

A review of past LERs identified four events (LERs 79-15/2L, 80-23/3X, 82-55/3X, and 83-01/3X) in which a fluctuation or loss of inverter voltage resulted in ESFAS actuations and/or component actuations. There were no similar events in which the voltage regulator board failed resulting in a unit trip and ESFAS actuations.

BALTIMORE
GAS AND
ELECTRIC

CALVERT CLIFFS NUCLEAR POWER PLANT
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CHARLES H, CRUSE
PLANT GENERAL MANAGER
CALVERT CLIFFS

February 18, 1994

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

ATTENTION: Document Control Desk

SUBJECT: Calvert Cliffs Nuclear Power Plant
Unit No. 1; Docket No. 50-317; License No. DPR 53
Licensee Event Report 94-001
Unit 1 Reactor Trip and ESFAS Actuation Due to 12 120 VAC Inverter

The attached report is being sent to you as required under 10 CFR 50.73 guidelines. Should you have any questions regarding this report, we will be pleased to discuss them with you.

Very truly yours,

CHC/MDM/bjd
Attachment

cc: D. A. Brune, Esquire

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